PHOTOMETRICS LTD.

HIGH PERFORMANCE CCD CAMERAS • DIGITAL IMAGING SYSTEMS

STAR I

CCD DIGITAL IMAGING SYSTEM

STAR I:

The CCD Digital Imaging System —Now Within Your Reach

Star I is a state-of-the-art, cooled CCD imaging system that utilizes the same signal processing techniques used by major observatories. This signal processing and cooled CCD operation provide a system comparable to those available for observatory use—at a fraction of the cost! For example, a 10-second exposure of the Ring Nebula taken on an 8-inch telescope easily reveals the central star of this well known planetary.

The Star I System

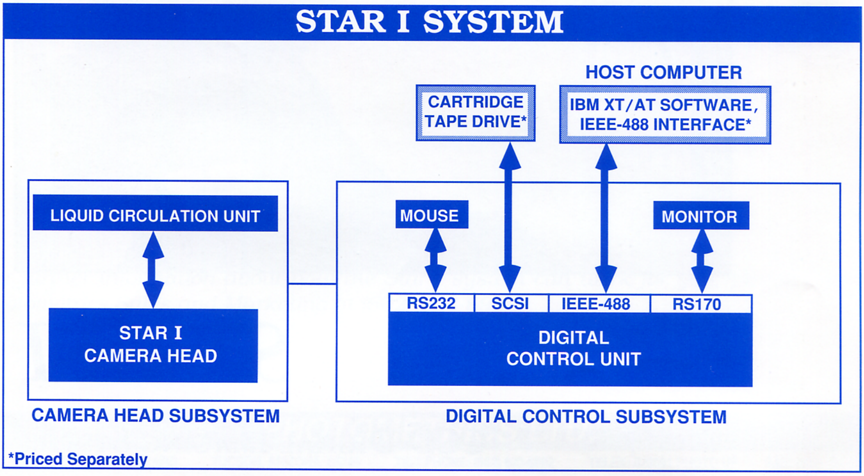
The Star I system consists of two subsystems. The camera head subsystem is composed of the lightweight Star I camera head and LC200 liquid circulation unit. The digital control subsystem includes the digital control unit, monochrome video monitor, and mouse.

Star I is a complete, standalone digital imaging system controlled by the mouse. As an option, the system can be interfaced with the user's IBM AT, XT, or compatible computer equipped with 640 kbytes of RAM. A DC2000 cartridge tape drive is available for additional image archiving and retrieval capability.

Camera Head Subsystem

The heart of the Star I camera head is a scientific-grade CCD imager. This imager has exceptional charge transfer efficiency, quantum efficiency, and dynamic range. It has 23-micron-square pixels on a 384 x 576 matrix, a 250,000 electron full well capacity, and a typical readout noise of 25 electrons.

To achieve top performance from the Star I camera head, the CCD is cooled to -35°C with a three stage thermoelectric cooler. Cooling reduces the dark current to 10 electrons/second/pixel. The LC200

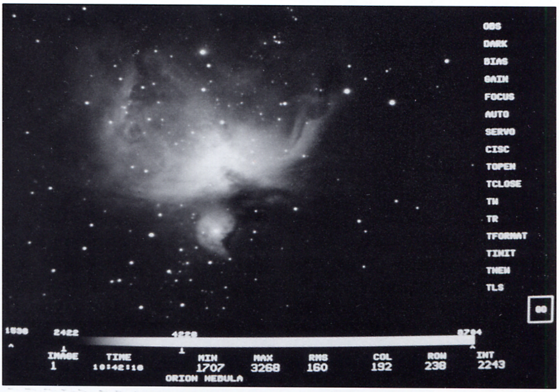


STAR I SYSTEM

*Priced Separately

circulates liquid through the camera head to dissipate the heat generated by the thermoelectric cooler.

The Star I camera head features a standard Nikon bayonet mount, 50mm f/2.0 lens, and shutter. Four tapped mounting holes are provided for rigid attachment of the camera head to your telescope while maintaining optical alignment in any orientation.



Monochrome video monitor showing mouse-driven display and CCD image of Orion Nebula using a logarithmic display scale.

Digital Control Subsystem

A compact digital control unit (DCU) operates the camera head from a distance of up to 10 feet. It is supplied with a mouse, RS170-compatible video monitor, and IEEE-488 port.

The DCU contains the slow scan electronics and image RAM used to digitize and store an image. It operates from 110 volts AC, 50 to 60 Hz. As an option, the system is available with 220 volt input.

The system control firmware includes all image acquisition and display commands for standalone use and commands for data transfer and storage on the user's host computer or optional DC2000 cartridge tape drive (see Options). Commands are displayed on the video monitor as they are executed.

Image Acquisition

The mouse-driven menu structure of Star I makes it easy to select commands that clear the CCD of residual charge, set the system gain, control shutter timing, frame a subarray to facilitate focusing, and expose an image. Exposures from hours down to 0.1 seconds are possible. A precision analog-to-digital (A/D) converter digitizes the CCD output to 12 bits/pixel at a rate of 97 kHz. Image readout takes 2.28 seconds.

Image Display

The digital-to-analog (D/A) converter that drives the video display is limited to eight bits (pixel intensity values of 0 to 255), although the image data are 12 bits (values of 0 to 4095). In order to display images with optimal contrast levels, the visual presentation of image data is scaled by a process known as windowing.

Using the mouse, the user selects a range of pixel intensity values within an image, which are then expanded or compressed to fill the range of the video display. All values below the range of interest are displayed as black, all above the range as white. All pixel intensities within the range are translated by a linear table from the low value to the high value. A mouse-operated bar display sets the windowing.

Normally, the video display contains the full image obtained with the CCD. The mouse may be used to zoom in on a portion of the image by factors of either 2 or 4. While in zoomed mode, the mouse may be used to center any part of the image in the video display.

A status line on the video display gives the current cursor location and pixel intensity value at that location, as well as the current command and its status, the time, and CCD temperature.

Image Transfer and Storage

For image transfer and storage, the Star I system must include the optional DC2000 cartridge tape drive or be interfaced with

M65, M66, and NGC 3628: 1-minute exposure obtained with a 6-inch f/5 Newtonian telescope.

a host IBM AT, XT, or compatible computer.

Options

Options for the Star I system include the DC2000 cartridge tape drive and image processing software.

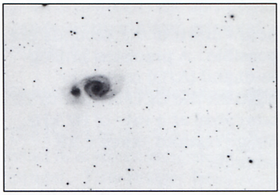
DC2000 Tape Drive

A formatted external 40 Mbyte DC2000 cartridge tape drive (1/4-inch tape) is available for image storage and retrieval. This tape drive is well suited for field use or situations where a host computer is not immediately available. Connection with the camera system is made using a SCSI port on the DCU. All tape operations, including formatting, are under control of the mouse.

IBM AT/XT Image Processing Software and IEEE-488 Interface

This optional package provides the hardware and software required for image processing on the user's IBM AT, XT, or compatible computer. The computer link is made via an IEEE-488 interface to the DCU.

Image processing software allows the user to manipulate digital image data from the host computer. Images may be calibrated and intensity plots generated across individual image rows or columns. Maximum, minimum, and mean pixel values, as well as the root mean square (RMS) value of the displayed image, may be derived.



M51 as seen on an inverted video display.

Horsehead Nebula: 30-second exposure obtained with a 6-inch f/5 Newtonian telescope

The image display capabilities of the DCU can be greatly enhanced by a host system. The standalone system uses a linear lookup table to convert the pixel values in the image into intensities on the video monitor. A host system can download a non-linear lookup table to the DCU. A logarithmic display scale, for example, is often very useful in the viewing of astronomical images.

For further information about how the Star I system can work for you, please contact Photometrics Sales and Marketing at (602) 623-6992.

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PHOTOMETRICS LTD.

CCD Cameras • Digital Imaging Systems

STAR I SYSTEM SPECIFICATIONS

Mechanical Specifications

Star I Camera Head

- Diameter: 4.5" (11.4 cm)
- Length: 4.25" (10.8 cm), exclusive of lens
- Weight: 2.5 lbs (1.1 kg)

Digital Control Unit

- Size: 15" (38.1 cm) x 13" (33 cm) x 5" (12.7 cm)
- Weight: 25 lbs (11.25 kg)
- External connections
  - IEEE-488 (GPIB) port to interface to the user's host computer
  - SCSI port for the optional tape drive interface
  - RS232 serial port for the mouse
  - BNC connector for the RS170 video display
  - 36 pin camera connector
  - AC input connector

LC200 Liquid Circulation Unit

- Size: 11" (28 cm) x 7.5" (19 cm) x 8" (20.3 cm)
- Weight: 14.5 lbs (6.5 kg)

Performance Specifications

CCD

- Format: 384 x 576 pixels
- Pixel size: 23 x 23 microns
- Readout noise: 25 electrons typical at 97kHz
- Charge transfer efficiency: 0.99998
- Full well capacity: 250,000 electrons/pixel
- Sensitivity: See attached QE curve
- Dark current: 10 electrons/sec/pixel at -35°C

Camera Head

- Shutter opening time: Less than 10 ms
- Shutter closing time: Less than 10 ms
- CCD temperature: -35°C
- Temperature control may be disabled for maximum cooling

Digital Control Unit

- 640 x 480 image video RAM with realtime zoom and windowing
- Alphanumeric display of time, CCD temperature, cursor location, and pixel intensity values
- Standalone operation using a mouse
- Standalone tape drive capacity: 40 Mb

Electrical Specifications

Star I Camera Head

- All signals and drive voltages required for camera head operation are derived from the Digital Control Unit
- Maximum camera cable length: 10 ft (3 m)

Digital Control Unit

- Input power requirements: 200 watts
- AC line power requirements: 115 VAC, 48-66 Hz (220 VAC, 48-66 Hz optional)

LC200 Liquid Circulation Unit

- Input power requirements: 45 watts
- AC line power requirements: 115 VAC, 48-66 Hz (220 VAC, 48-66 Hz optional)

Firmware Commands

obs *Initiate a user-selected integration and read out the CCD*

dark *Initiate an integration without opening the shutter*

bias *Obtain a 0-length integration to measure the background level*

gain *Set the system gain parameter*

focus *Begin the focus routine*

auto *Enable the automatic calculation of the windowing*

servo *Turn on the temperature servo*

cisc *Continuously clear the CCD array*

topen *Open the cartridge tape drive**

tclose *Close the cartridge tape drive**

tw *Write an image to the cartridge tape**

tr *Read an image from the cartridge tape into image video RAM**

tformat *Format the tape cartridge**

tinit *Initialize the cartridge tape drive**

tnew *Write an image header onto the cartridge tape**

tls *List the image headers that are on the cartridge tape**

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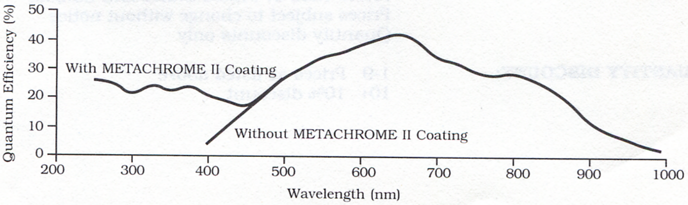
*Command used with cartridge tape option



Star I CCD Quantum Efficiency Curve (-35°C)

DOMESTIC PRICE SCHEDULE
Effective Date: October 1, 1988

STAR I CAMERA SYSTEM

Star I System:

- Star I Camera Head
- Scientific-grade CCD imager
- Nikon lens
- Digital Control Unit and mouse
- LC200 Liquid Circulation Unit
- 12-inch diagonal high performance monochrome RS170 monitor
- Power strip

Star I System Price	$12,000.00

Star I System Options:

DC2000 Cartridge Tape Drive	$ 2,500.00
IBM AT/XT Image Processing Software and IEEE-488 Interface	$ 650.00
METACHROME™ II ultraviolet response-enhancement coating applied to Star I CCD with original order	$ 1,900.00

DELIVERY AND PRICING POLICIES

DELIVERY:	90 days ARO
WARRANTY:	Six months from shipping date
SHIPPING	F.O.B. Tucson, Arizona, U.S.A. Shipping Point: Tucson, Arizona, U.S.A. Prepaid and billed
PRICING:	All prices quoted in U.S. currency Prices valid in United States and Canada Prices subject to change without notice Quantity discounts only
QUANTITY DISCOUNT:	1-9 Prices as listed above 10+ 10% discount

Export prices quoted upon request.

Prices subject to change without notice.